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# Next Generation Technology for Today's Energy

Jason Begger, Executive Director
Wyoming Infrastructure Authority

# Tenant Support and Operations

- EFA is technical and operations contractor
  - Engineering, permitting, site support
  - Staffed by Gillette-based personnel
- Hladky Construction is site services contractor
- EPA/DEQ permit clarification for Basin Electric
- WIA responsibilities
  - Negotiating contracts
  - Electrical service agreement with PreCorp
  - Insurance
  - Tours and public/media outreach
- Very lean and efficient operation
  - <$500,000 per year to operate
  - No FTE's

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# XPRIZE competition

Breathe (Bangalore, India) – Led by Dr. Sebastian Peter, the team is producing methanol, a common fuel and petrochemical feedstock, using a novel catalyst.

Carbon Capture Machine (Aberdeen, Scotland) – Led by Dr. Mohammed Imbabi, the team is producing solid carbonates with applications to building materials.

C4X (Suzhou, China) – Led by Dr. Wayne Song and Dr. Yuehui Li, the team is producing chemicals and bio-composite foamed plastics.

Dimensional Energy (Ithica, NY, USA) – Led by Jason Salfi, the team is using artificial photosynthesis to produce environmentally responsible polymers and chemical intermediaries for industrial partners.

Carbon Upcycling UCLA (Los Angeles, CA, USA) – Led by Dr. Gaurav Sant, the team is producing building materials that absorb CO2 during the production process to replace concrete.

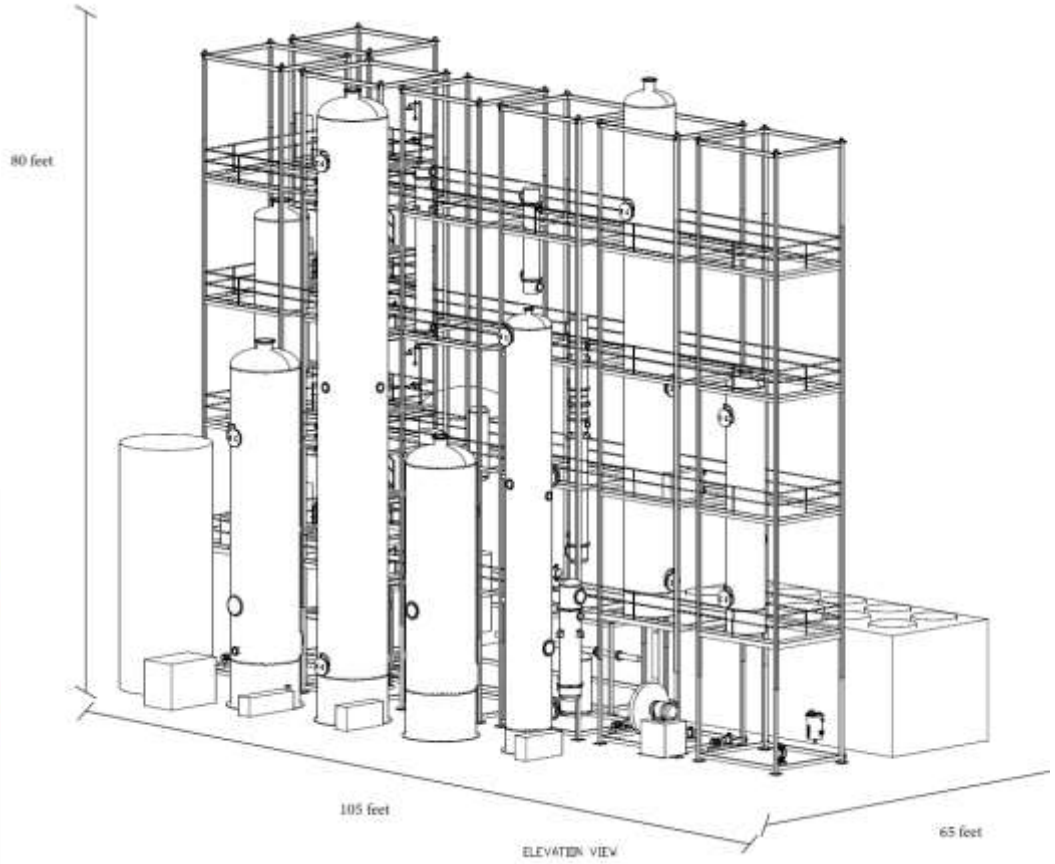
XPRIZE is a temporary tenant of the ITC and at the completion of the competition, the space will be available to new testers.

# Membrane Technology and Research

- MTR has a successful $CO_2$ capture research portfolio.
- Has received initial phase 1 funding from U.S. DOE.
- Partnering with Wyoming ITC for phase 2 application for design and permitting and phase 3 operation.
- 200 ton per day of liquid $CO_2$ product system will be located in the large test bay.

Photo Credit: NETL

# University of Kentucky




- UK has a solvent based $CO_2$ capture system.
- Has received initial phase 1 funding from U.S. DOE.
- Partnering with Wyoming ITC for phase 2 application for design and permitting and phase 3 operation.

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Photo Credit: UK

# TDA Research

- TDA – based in Wheat Ridge, CO
- Skid-based Hybrid membrane/sorbent test system
- Finalizing permitting, lease and insurance
- Testing to begin in June 2019

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# JCOAL – KHI

- July 2016 – State of Wyoming - JCOAL (Japan Coal Energy Center) MOU
- April 2017 – WY delegation meetings in Japan
- Sept. 2017 – JCOAL/UWSER conference in Gillette
- March 2018 – WY delegation meetings in Japan
- April 2018 – Announcement of JCOAL-KHI (Kawasaki Heavy Industries) test at ITC – dry sorbent, fixed bed technology
- May 2018 – Japan Ministry of Environment, JCOAL and KHI trip to Gillette
- August 2018 – Feasibility trip to Gillette
- December 2018 – Met with US based EPC firms
- February 2019 –Wyoming permitting trip

# Business Development

- Active rather than passive recruitment process
- Partnership with National Carbon Capture Center
- International Carbon Capture Test Centre Network
- Engaging with researchers and stakeholders
  - International Energy Agency
  - Pittsburgh Coal Conference
  - NETL Clean Coal Conference
  - GHGT – 14
- Additional amenities and infrastructure
  - Emissions monitoring equipment
  - Control room
  - Natural gas line/steam boiler

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# Coordinating the Opportunity

- University of Wyoming School of Energy Resources
- Center for Economic Geology Research
- Enhanced Oil Recovery Institute
- Wyoming Integrated Test Center
- Wyoming Corridor Initiatives
- ENDOW

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School of
Energy Resources
UNIVERSITY OF WYOMING

Enhanced Oil
Recovery Institute
UNIVERSITY OF WYOMING

Center of Excellence
for Economic Geology Research
SCHOOL OF ENERGY RESOURCES

# Policy and Finance Development

- Congressional Testimony
  - July 2017 – US Senate Committee on Environment and Public Works
  - July 2018 – US House Committee on Science
- Policy development
  - Congressional Delegation
    - AML, 45Q, USE IT Act
  - State level incentives and rules
    - UW SER, ISO
    - PSC, NARUC
- New financing options
  - Foundations, high tech
  - Sovereign wealth funds

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# International Recognition


Peabody Clean Coal Leadership Award: Carbon Capture Pioneer

Presented at the PowerGen International Conference

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# Next Steps

- Additional Tenants
- Partnership opportunities with CarbonSafe, EORI, others
- Promote ITC to potential tenants
- Finalize operations and business plans
- Provide technical assistance to tenants
- Explore alternative financing mechanisms
  - Accounting
  - Investment products

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# CCUS Activities

CarbonSafe well with Dry Fork Station in background. April 2019
Credit: University of Wyoming

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# Wyoming efforts

- Glenrock Petroleum – MHI technology at Dave Johnston Plant near Glenrock for EOR
  - Working with Rocky Mountain Power (RMP) and applying for DOE FEED funding
- Jupiter Oxygen – Propriety Oxy-fueled combustion
  - Working with RMP at Dave Johnston Plant near Glenrock
  - Applying for DOE FEED funding
- Membrane Technology Research (MTR) – Proprietary membranes at Dry Fork Station
  - Applying for DOE FEED funding
- University of Kentucky – Proprietary solvent technology
  - Hoping to partner with RMP for DOE FEED funding at Jim Bridger Plant
- University of Wyoming SER - Proprietary Oxy-fueled Combustion
- Sustainable Energy Solutions (SES) – Cryogenic separation technology
  - UW SER supported
  - Exploring capture capabilities for XPRIZE teams

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# NET Power

## 50MW$_{TH}$ DEMO PLANT RUNNING IN TEXAS

**50 MWTH GRID-CONNECTED PLANT**

- SCALED FROM 500MWTH DESIGN

**$160M+ PROGRAM**

**FIRST FIRE ACHIEVED MAY 2018**

**PRIMARY EQUIPMENT BLOCKS**

1. FUEL GAS COMPRESSOR
2. OXIDANT COMPRESSOR
3. OXIDANT PUMP
4. HEAT EXCHANGER TRAIN
5. TURBINE
6. $CO_2$ COMPRESSOR
7. $CO_2$ PUMP
8. COMBUSTOR TEST RIG
9. TURBINE GLAND SEAL COMPRESSOR


La Porte, TX Demonstration Plant

Exelon MCDERMOTT 8 RIVERS

NETPOWER

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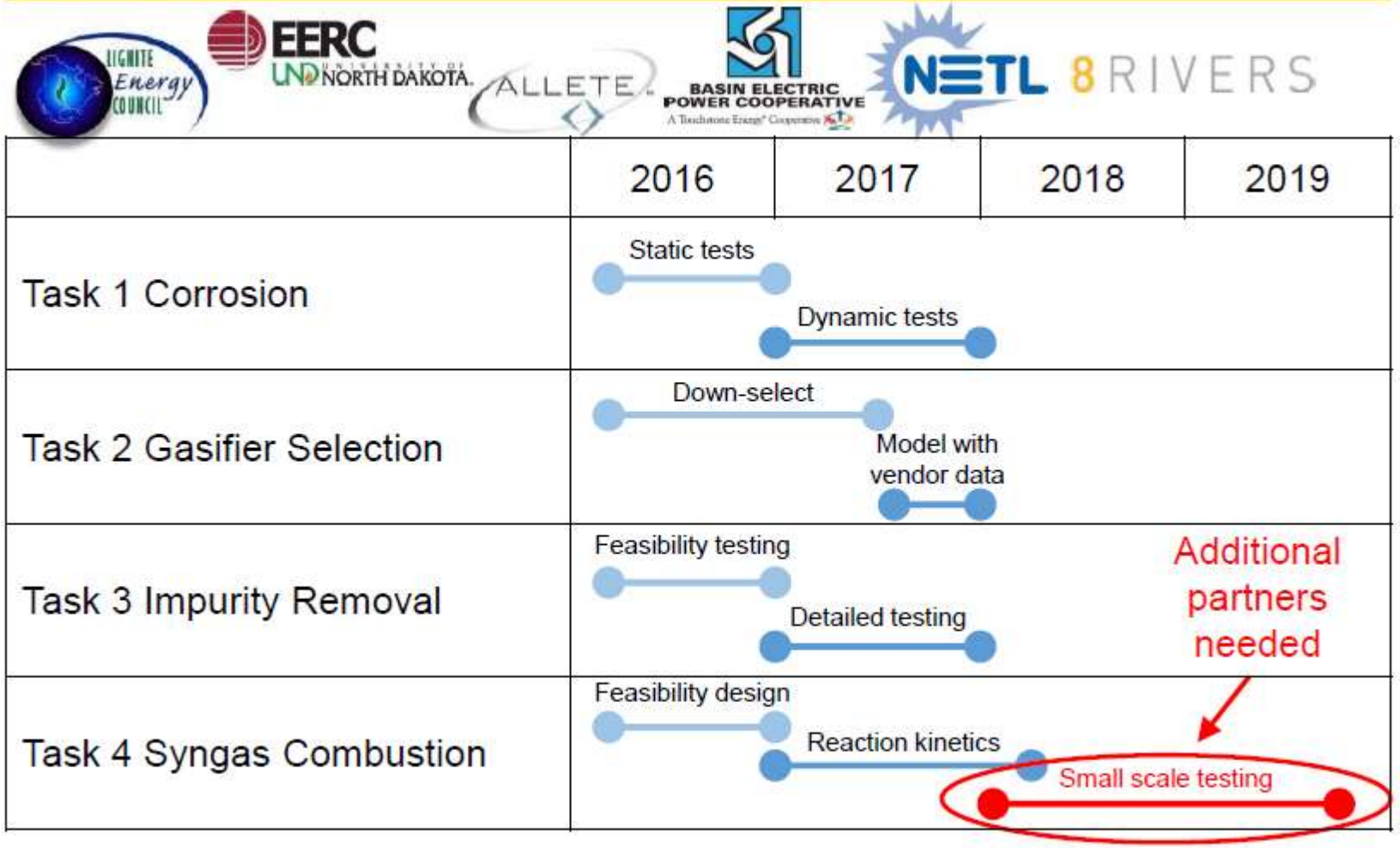
# NET Power – coal program

## Development Program Underway




8 RIVERS

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# Project Tundra

- Proposed post-combustion carbon capture at the Milton R. Young Power Plant near Center, ND
  - Lignite fueled
  - Constructed in 1977, Unit 2 – 455 MW
- Utilize Mitsubishi Heavy Industries technology – similar to Petra Nova
- Capture 90% of CO2 – up to 3.6 million tons annually
- $1.3 billion in total costs

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# Project Tundra

**Project Roadmap:**

### Key Technology Improvements:

Addressing the key technical challenges from recent projects to improve efficiency and performance.

### Project Feasibility

Advance technology, partnerships and funding.

Federal and State funding, and tax credit support.

### Initial Design, $CO_2$ for EOR and Sequestration:

Project design and assessment of $CO_2$ for EOR and sequestration.

Federal and State funding for FEED and pilot work.

### Large Pilot Testing and FEED:

FEED for full project and arrangements for $CO_2$ offtake sequestration.

Large flue gas pilot testing at MR Young Station, if needed.

Finalize full Federal and State support.

### Commercial Application:

Detailed engineering, procurement and construction.

Operation and affirmation of capture, EOR and sequestration solutions for industry.

**Timeline and Cost Estimate:**

| 2015-2016 | 2016-2017 | 2018-2019 | 2020-2021 | 2022-2024 |
|---|---|---|---|---|
| **$1 million** | **$1 million** | **$30 million** | **$100 million** | **$1.3 billion** |

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# DOE Funding Opportunities

- *Fossil Fuel Large-Scale Pilots*
  - Funds two pilots, up to $40 million each, with minimum of 20% non-federal match
- *Regional Initiative to Accelerate Carbon Capture, Utilization, and Storage*
  - $20 million in federal funding for cooperative agreements to accelerate the deployment of carbon capture, utilization, and storage (CCUS)
- *Critical Components for Coal FIRST Power Plants of the Future*
  - $100 million in federal funding for cost-shared R&D projects that focus on developing the critical components required by Coal FIRST systems
- *Next Generation Gasifier Concepts and Components to Advance Modular Coal Gasification*
  - cost-shared research and development (R&D) projects on next-generation coal gasification technologies
- *Advancing Steam Turbine Performance for Coal Boilers* - $ 22 million
- *Transformational Sensing Systems for Monitoring the Deep Subsurface* - $4.8 million
- *Crosscutting Research for Coal-Fueled Power Plants* - $14.5 million
- *Advanced Materials for High-Efficiency, Flexible and Reliable Coal-Fueled Power Plants* - $26 million
- *Process Scale-Up and Optimization/Efficiency Improvements for Rare Earth Elements (REE) and Critical Materials (CM) Recovery from Coal-Based Resources* - $20 million
- *Developing Technologies for Advancement of Associated Geologic Storage for Basinal Geo-Laboratories*
  - *UW CarbonSafe*

**$292,300,000 in funding opportunities**

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# Policy Opportunities

- Federal funding will almost always require a 20%, non-federal match
  - North Dakota diverts 10 cents per ton of coal into the *Lignite Research, Development and Marketing Program*
    - About $3 million per year to provide cost-share opportunities
  - Wyoming could develop similar program
- Innovative ratemaking for regulated utilities adopting CCUS
- Resource pricing metrics that take into account other attributes (e.g., reliability)
- Pursue potential new opportunities (e.g., grid-scale storage) that could have commercial relevance and economic benefit for Wyoming
- Definitions of “clean” that include CCS/CCUS, high-efficiency
- Revisit CO2 liability discussions from a decade ago

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